

Inventory & Monitoring Program Pacific Island Network Monitoring Plan

Appendix A: Vertebrate Fauna Report

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Pacific Island Network (PACN)

Territory of Guam
War in the Pacific National Historical Park (WAPA)

Commonwealth of the Northern Mariana Islands American Memorial Park, Saipan (AMME)

Territory of American Samoa
National Park of American Samoa (NPSA)

State of Hawaii

USS Arizona Memorial, Oahu (USAR)

Kalaupapa National Historical Park, Molokai (KALA)

Haleakala National Park, Maui (HALE)

Ala Kahakai National Historic Trail, Hawaii (ALKA)

Puukohola Heiau National Historic Site, Hawaii (PUHE)

Kaloko-Honokohau National Historical Park, Hawaii (KAHO)

Puuhonua o Honaunau National Historical Park, Hawaii (PUHO)

Hawaii Volcanoes National Park, Hawaii (HAVO)

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EXECUTIVE SUMMARY

The terrestrial vertebrate fauna workgroup report addresses native and alien vertebrate animal populations and communities found within parks. Native vertebrates that are likely to be of high concern for monitoring include rare species and groups; federally listed threatened or endangered species; animals with important functional roles in ecosystem processes such as pollination, seed dispersal, etc.; animals with special cultural significance; and animals that serve as indicators of natural or anthropogenic environmental change. Alien vertebrates of particular concern for monitoring include species parks are controlling (or want to control) due to their ability to reduce native biodiversity, species that pose specific threats to high priority native plants or animals, and species that pose identified or potential human health risks (i.e., rats as vectors of leptospirosis in freshwater sources, soil, campgrounds/campsites, picnic areas etc). Marine birds, water birds and shorebirds are also considered here.

This report's objectives are to identify and summarize existing knowledge and understanding of terrestrial vertebrate fauna, as well as to identify important information gaps. In conjunction with other working group reports, this information will be used to prioritize, design and construct a comprehensive ecological monitoring program for the networks' eleven parks.

The islands covered in this report are located in Micronesia in the western Pacific (WAPA, AMME), the main Hawaiian Islands in the central Pacific (ALKA, HALE, HAVO, KAHO, KALA, PUHE, PUHO, USAR), and American Samoa in the south central Pacific (NPSA). The native terrestrial vertebrate fauna in Pacific Island parks is quite depauperate when compared to the continental US, Asia, or continental islands. Smaller land areas and concomitantly smaller populations, plus high levels of endemism, make many threats potentially more serious in the Pacific islands than in mainland situations.

Legal mandates concerning terrestrial fauna include federal legislation for endangered species and migratory birds, NPS regulations, enabling Legislation, NPS Management Policies (2001), Executive Orders, Director's Orders, and CNMI, American Samoa, Guam and Hawaii State and local laws pertaining to wildlife.

A **conceptual model** is required by the NPS's Inventory and Monitoring program to facilitate communication between managers, scientists, stakeholders and the public during the monitoring planning process. The terrestrial vertebrate fauna workgroup developed a stressor-focused model for native terrestrial fauna in PACN parks with the following components: **drivers**, which cause major ecosystem change; **stressors**, physical, chemical or biological perturbations to a system resulting from model drivers; and **ecosystem responses** to stressors.

Past, existing or on-going terrestrial vertebrate monitoring primarily concentrates on rare or listed species and on alien mammals. Terrestrial vertebrate monitoring needs identified by network parks focus on rare or listed species and those with cultural significance. Stressors identified by parks fell into the following categories: invasive aliens and biodiversity loss, climate change (including sea level rise), lava flows, and fire or altered fire regimes.

Identified information needs include editing and clean-up of the NPSpecies (inventory) database for all parks. Additionally, ALKA, AMME and WAPA need baseline inventories of their vertebrate terrestrial fauna.

INTRODUCTION

SCOPE OF TOPIC AREA

The vertebrate fauna group addresses native and alien vertebrate animal populations and communities found within parks. Native vertebrates that are likely to be of high concern for monitoring include: a) rare species and groups, b) federally listed threatened or endangered species, c) animals with important functional roles in ecosystem processes such as pollination and seed dispersal, d) animals with special cultural significance and e) animals that serve as indicators of threats to, or declines in, communities or ecosystems. Alien vertebrates of particular concern for monitoring include: species parks are controlling (or want to control) due to their ability to reduce native biodiversity, species that pose specific threats to high priority native plants or animals, and species that pose identified or potential human health risks (i.e., rats as vectors of leptospirosis in freshwater sources, soil, campgrounds/campsites, picnic areas etc). Marine vertebrate fauna and freshwater aquatic animals will not be considered, as both of these are covered by their respective workgroups. Marine birds, water birds and shorebirds will be addressed in this report.

BACKGROUND

The islands covered in this report are located in Micronesia in the western Pacific (WAPA, AMME), the main Hawaiian Islands in the central Pacific (ALKA, HALE, HAVO, KAHO, KALA, PUHE, PUHO, USAR), and American Samoa in the south central Pacific (NPSA).

The native terrestrial vertebrate fauna in Pacific Island parks is quite depauperate when compared to the continental US, Asia, to continental islands. Smaller land areas and concomitantly smaller populations, plus high levels of endemism, make many threats potentially more serious in the Pacific islands than in mainland situations. For example, avian diseases such as malaria that are naturally part of US mainland ecosystems are alien in Hawaii. In Hawaii, avian disease has been devastating to native land birds. Thus, incipient or potential threats also must be evaluated with the fragility of remote island fauna in mind. For example, West Nile Virus, carried by infected mosquitoes possibly entering Hawaii through air and sea cargo, could have dire consequences for native species in Hawaii and other Pacific islands. Additionally, there may be distinct cultural affiliations between Hawaiian and Pacific Islanders and their native wildlife, and perhaps also some early vertebrate introductions.

MONITORING GOALS AND OBJECTIVES

The goals and objectives for vertebrate fauna issues are to identify and summarize existing knowledge and understanding of terrestrial vertebrate fauna, as well as important information gaps. In conjunction with other working group reports, this information ultimately will be used to prioritize, design and construct a comprehensive ecological monitoring program for the networks' 11 parks. Terrestrial vertebrates could be included in the network's monitoring based on their roles as important components of ecosystems, indicators of broader natural or anthropogenic environmental change, or as keystones in native ecosystems.

LEGISLATION AND POLICY

As a federal agency, the NPS operates under a hierarchy of legislative mandates, including federal laws, executive orders, Department of the Interior and NPS policies and directives, as well as county, state, commonwealth, and territorial regulations. Further, management of submerged resources is complicated by jurisdictional or administrative issues that are often managerially more challenging than similar issues on land. These complexities require the NPS to cooperate with numerous and often overlapping federal and local agencies to achieve its objectives.

I & M - NATURAL RESOURCE CHALLENGE

The Natural Resource Challenge (NRC), initiated in 1999, is an action plan for preserving natural resources through the National Park Service (NPS). The NRC assisted NPS to establish 32 Inventory and Monitoring networks, which includes 270 National Parks. In the Networks, parks are grouped that share geographical and natural resource characteristics. The Inventory and Monitoring (I&M) Program is designed to first complete basic inventories of natural resources in parks, on which to base long-term monitoring efforts. Monitoring programs are based on monitoring critical parameters (Vital Signs) within each network to incorporate into natural resource management and decision-making. "Vital Signs are measurable, early warning signals that indicate changes that could impair the long-term health of natural systems" (NPS, 2003).

INTERNATIONAL

Endangered Species Act

Endangered Species Act of 1973, administered by the U.S. Fish and Wildlife Service and National Marine Fisheries Service. Purposes for the Endangered Species Act include; ecosystems upon which endangered and threatened species depend on may be conserved, all federal departments and agencies shall seek to conserve endangered and threatened species, and each federal agency shall insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species. Theses actions are primarily carried out via endangered species permits for activities that directly involve listed species; section 7 consultations for actions not covered under an endangered species permit that may affect listed species; and recovery plans, which NPS should strive to carry out applicable portions whenever possible.

Migratory Bird Treaty Act

Unless permitted by regulations, the Act provides that it is unlawful to pursue, hunt, take, capture or kill; attempt to take, capture or kill; possess, offer to or sell, barter, purchase, deliver or cause to be shipped, exported, imported, transported, carried or received any migratory bird, part, nest, egg or product, manufactured or not. Subject to limitations in the Act, the Secretary of the Interior (Secretary) may adopt regulations determining the extent to which, if at all, hunting, taking, capturing, killing, possessing, selling, purchasing, shipping, transporting or exporting of any migratory bird, part, nest or egg will be allowed, having regard for temperature zones, distribution, abundance, economic value, breeding habits and migratory flight patterns.

FEDERAL

Executive Orders

Executive Orders are official documents, numbered consecutively, through which the President of the United States manages the operations of the Federal Government.

Executive Order 13112: Invasive Species/ Exotic Species: prevent the introduction of invasive species, detect and respond rapidly to and control population in cost effective and environmentally sound manner, monitor aliens species populations, provide restoration of native species and habitat conditions in ecosystems that have been invaded. Conduct research on invasive species and develop techniques to prevent introductions and sound control of invasive species, promote public education on invasive species and means to address them.

Executive Order 11990: Protection of Wetlands; requires all federal agencies to "minimize the destruction, loss, or degradation of wetlands, and preserve and enhance the natural and beneficial values of wetlands". Unless no practical alternative exists, federal agencies must avoid any activities that have the potential to adversely affect wetland ecosystem integrity. NPS guidance pertaining to this Executive Order is stated in Floodplain and Wetland Protection Guidelines (National Park Service, 1980).

<u>NPS</u>

The National Park Service Organic Act

Under the NPS Organic Act the National Park Service shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations here in after specified by such means and measures as conform to the fundamental purposes of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations. The 1916 National Park Service Organic Act is the core of park service authority and the definitive statement of the purposes of the parks and of the National Park Service mission. The act establishes the purpose of national parks: ".... To conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

Park Enabling Legislation

The act establishing NPSA recognized the importance of the park's tropical vegetation as one of the last remaining undisturbed paleotropical forests and as habitat of Pacific flying foxes. Enabling legislation at HAVO and HALE states that regulations shall provide for the preservation from injury, of all timber, birds, mineral deposits, and natural curiosities or wonders within, and retained in their natural condition as nearly as possible. Enabling legislation for all other parks within the PACN does not have specific language regarding terrestrial vertebrate fauna.

NPS Management Policies

The NPS management policies are designed to provide NPS management and staff with clear and continuously updated information on NPS policy and required and/or recommended actions, as well as any other information that will help them manage parks and programs effectively. Management policies pertaining to vertebrate fauna include the following:

Restoration of Natural Systems 4.1.5. Re-establish natural functions and processes, biological and physical components and biological community structure. Examples include; removal of exotic species, removal contaminants and non-historic structures, and restoration of native plants and animals.

Plant and Animal Population Management Principles 4.4.1.1. Parks should work with partners to manage species that cross park boundaries or are also found outside parks.

Management of Native Plants and Animals 4.4.2. Specifies when intervention is permissible to maintain native species. Examples include when a population occurs in an unnaturally high or low concentration as a result of human influences and it is not possible to mitigate the effects of the human influences; to protect rare, threatened, or endangered species; and where intervention meets specific park management objectives.

Restoration of Native Plant and Animal Species 4.4.2.2. Specifies when to restore and limits highly manipulative activities for restoration.

Management of Threatened or Endangered Plants and Animals 4.4.2.3. The NPS will survey for, protect, and strive to recover all species native to the national park system units that are listed under the Endangered Species Act and fully meet obligations under the NPS Organic Act.

Maintenance of Altered Plant Communities 4.4.2.5. Limits and prohibits the use of exotic species to maintain Threatened and Endangered Species.

Removal of Exotic Species Already Present 4.4.4.2. Prioritizes management and eradication of exotic species already present within a park.

Biotic Cultural Resources 5.3.5.2.5. Management of biological resources with cultural significance.

NPS-supported Studies 8.11.2. Inventory, monitoring, research studies to support management needs and objectives.

Natural Resource Management Guidelines: Native Animal Management, Hunting and Trapping, Subsistence and other Traditional Uses

Director's Orders

Director's orders provide guidance for implementing certain aspects of NPS management policies, and are used as a vehicle for updating Management policies between publishing dates.

Director's Order #77-1: Wetland Protection: the purpose of this Director's order is to establish National Park Service Policies, requirements, and standards for implementing Executive Order 11990: Protection of Wetlands, to avoid to the extent possible the long and short term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practical alternative.

REGIONAL

State of Hawaii

Chapter 195D-1 thru 5 of the State of Hawaii Revised Statues

These Statues are administered by the State of Hawaii, Department of Land and Natural Resources (DLNR). These laws state that it is unlawful to take, possess, transport, export, process, sell, offer for sale, or ship a species of aquatic life, wildlife, or land plants in need of conservation, except when permitted by DLNR. DLNR may determine an indigenous species to be endangered or threatened because of any of these factors: the present or threatened destruction, modification, or curtailment of its habitat or range; over utilization for commercial, sporting, scientific, educational, or other purposes; disease or predation; inadequacy of existing regulatory mechanisms; or other natural or manmade factors affecting its continued existence within Hawaii. DLNR is also authorized to acquire by purchase, donation or otherwise lands or interests therein needed to carry out conservation programs.

Hawaii Tropical Forest Recovery Act (1992)

This act authorizes the Secretary of Agriculture and the US Forest Service to establish biological control agents for non-native species. Creates task force to develop action plan to: "promote public awareness of the harm caused by introduced species" develop recommendations on "the benefits of fencing or other management activities for the protection of Hawaii's native plants and animals from non-native species, including the identification and priorities for the areas where these activities are appropriate

Commonwealth of the Northern Mariana Islands

Division of Fish and Wildlife

The CNMI Division of Fish and Wildlife is mandated by local law (Public law 2-51) to establish clear and uniform regulations governing hunting, fishing, conservation of fish and wildlife, and endangered species. Fish and Wildlife regulations are developed in order to conserve and preserve our Wildlife resources and their habitat. The regulations establish hunting and fishing seasons, legal and illegal equipment, declare endangered species, and determine sensitive habitat. See website www.dfw.gov.mp/interest.htm for details.

American Samoa

Department of Marine and Wildlife Resources (DMWR)

The functions of the American Samoa Department of Wildlife Resources (DMWR) are to protect and manage American Samoa's marine and wildlife resources to the extent intended to best benefit the people of American Samoa while ensuring the integrity of such resources for posterity. The majority of DMWR's projects are federally funded through the Federal Aid in Wildlife and Sport Fish Restoration grants (Federal Aid in Wildlife Restoration Act of 1937) and

monies from the National Marine Fisheries Service (NMFS) Western Pacific Fish Information Network.

The American Samoa Coastal Management Program

The American Samoa Coastal Management Program is administered by the Department of Commerce under Public Law 21-35, the American Samoa Coastal Management Act of 1990, and ASCA 24.0501. The American Samoa Coastal Management Act mandates the establishment of a system of environmental review, along with economic and technical considerations, at the territorial level intended to ensure that environmental concerns are given appropriate consideration in the land use decision-making process. Coastal resources include: the land, air, water, minerals, flora, fauna, and objects of historic or aesthetic significance of the Territorial coastal zone. Coastal resources also include, but are not limited to, submerged lands, reef systems, groundwater recharge areas, archaeological/cultural/historic resource sites and properties, Special Management Areas, pristine ecosystems, mangroves, wetlands, beaches, areas of scientific interest, recreational areas, undisturbed native vegetation, and critical habitat. Local government agencies fall under this mandate.

Guam

The Department of Agriculture's Division of Aquatic and Wildlife Resources (DAWR) is delegate responsibility to manage and regulate fish and game in and about Guam under Title 5, Guam Code Annotated (GCA) in Section 63102. The Government of Guam has two legal forums to establish law, through the legislature or Departmental authority (i.e. DAWR). When the various Government of Guam Departments were created, they were delegated certain authorities, including the authority to make regulatory changes. In order to alter regulations, the agency must hold at least one public hearing, and then submit copies of the proposed changes, a copy of the add announcing the public hearing, a copy of the attendance list to the public hearing, and a copy of the hearing testimonies to the Attorney General's Office and then to the Governor. Upon registry at the legislature, the documents are open for 90 days. During the 90 days, the legislature can approve, alter, amend or disapprove the proposal. If no action is taken within 90 days they become law.

ECOLOGICAL CONTEXT

GEOGRAPHY

All the PACN network parks are located on tropical islands in the Pacific Ocean. Eight of the parks are in the Hawaiian Islands in the Central Pacific between 19 and 22 degrees North latitude. HAVO, KAHO, PUHE, PUHO, and the recently designated ALKA are on the island of Hawaii, the youngest of the main Hawaiian Islands at the southern and eastern end of the archipelago. HAVO is located on the southeast slope of Hawaii Island, where it extends from sea level to the summits of Kilauea and Mauna Loa Volcanoes. The newly designated Kahuku unit of HAVO is positioned on southern Mauna Loa and extends down both the eastern and western flanks of the volcano. PUHE, KAHO, and PUHO are coastal parks of the western side of the island. KAHO is centrally located with PUHE to the north and PUHO to the south. HALE is on Maui, the second youngest Hawaiian Island. HALE extends from sea level to the

summit of East Maui. KALA is on a peninsula projecting from the north shore of Molokai, centrally located in the main Hawaiian Islands. USAR is within Pearl Harbor on southern or leeward Oahu. Two PACN parks are situated in the western Pacific Ocean between 13 and 15 degrees north latitude in Micronesia. WAPA is on the western side of the island of Guam and AMME is on the west coast of Saipan, one of the Northern Mariana Islands. NPSA is on the Polynesian islands of American Samoa, approximately 13 degrees south latitude. One unit of NPSA is on the island of Tutuila, and three others are on Tau, Ofu, and Olosega of the Manua Island group 96 km (60 miles) east of Tutuila.

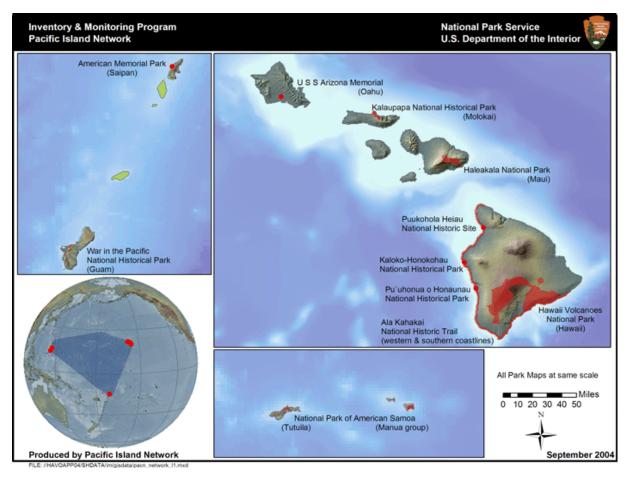


Figure 1. Pacific Island Inventory and Monitoring Network

GEOLOGY

The parks of the Western Pacific (WAPA, AMME) are on the islands of Guam and Saipan which have long-extinct volcanoes. These islands have complicated geologic origins involving both volcanism and subduction of the Marianas Trench. Hence, the northern half of Guam and portions of Saipan have limestone substrates elevated above a weathered volcanic base. WAPA units are on the volcanic substrates of the southern half of Guam, and at least one unit includes elevated limestone caps.

The islands of American Samoa and Hawaii are oceanic volcanic islands arising from hotspots. The oldest of the Samoan Islands are dated at more than two million years, but there was volcanic activity between Tau and Olosega approximately 150 years ago (Whistler 1994). In Hawaii, HALE protects the summit of the inactive Haleakala Volcano and its impressive crater, which is the result of stream erosion, the merging of Kaupo and Keanae Valleys, and subsequent volcanic activity. KALA encompasses the Kalaupapa peninsula, formed on the north shore of Molokai during the Pleistocene (MacDonald and Abbott 1970). The volcanoes on both Molokai and Oahu are extinct.

The five parks on Hawaii Island are on active or dormant volcanoes. A significant portion of HAVO is covered with recent lava flows that are sparsely vegetated. HAVO also contains the rift zones and summit calderas of both Mauna Loa and Kilauea Volcanoes, two of the most active volcanoes on earth. PUHO is on prehistoric pahoehoe flows of Mauna Loa, and PUHE substrates are old weathered soils of Kohala Volcano. All substrates of KAHO are flows from Hualalai Volcano less than 10,000 years old, including one sparsely-vegetated lava flow dated at 1,000-3,000 years (Moore *et al.* 1987).

ELEVATION GRADIENTS

Among the Hawaiian parks, HAVO and HALE have the greatest elevational range, extending from sea level to the summits of tall volcanoes >3,000 m (>10,000 ft) in elevation. KALA has an elevational range from sea level to almost 1,220 m (4,000 ft) elevation. The three parks of leeward Hawaii Island are coastal parks and extend upslope to an elevations less than 100 m. ALKA is also in the coastal lowlands of western and southern Hawaii Island.

Among the three Western Pacific parks, AMME is restricted to coastal lowlands on the western shore of Saipan. WAPA includes both coastal units and inland sites on the slopes of Mt. Alifan and Mt. Tenjo, with one unit extending above 305 m (1,000 ft) in elevation. NPSA is composed of four units; Ofu and Olosega are largely coastal but the Tutuila and Tau units range from sea level to 491 m (1,610 ft) and 966 m (3,170 ft) elevation, respectively. The planned expansion of NPSA on Ofu and Olosega will include the summits of both islands, which are 499 m (1,621 ft) and 639 m (2,096 ft) respectively.

RAINFALL AND CLIMATE

The largest two Hawaiian parks, HAVO and HALE, include within their boundaries several climatic zones with a range of rainfall regimes. HAVO contains two of the four rainfall minima of Hawaii Island, the Kau Desert with mean annual rainfall <750 mm and the interior lands of Mauna Loa. The highest mean annual rainfall within the park is found in Olaa Tract, a rain forest with >4,000 mm per year (Giambelluca *et al.* 1986). In general, the eastern windward portion of HAVO has high rainfall, which diminishes upslope, particularly above the trade wind inversion layer near 1,830 m (6,000 ft) elevation. The upper elevations of the park are moist to very dry, and the summit of Mauna Loa receives on average <500 mm precipitation. The leeward, western portions of HAVO are in rain shadows of Mauna Loa and Kilauea summit, and are typically dry.

HALE also has a range of climates, as it extends from sea level on the windward, eastern slope of Haleakala to the summit of East Maui. This park also includes lands in the leeward rain shadow of Haleakala, down to 1,220 m (4,000 ft) elevation. Annual precipitation in the park

varies from 1,250 mm in the Crater, the southern slope, and Kaupo Gap to >6,000 mm on the upper northeastern slopes of Haleakala. KALA, on the north shore of Molokai receives 1,000 mm of precipitation annually at sea level and >3,000 mm at the upper elevations of Waikolu Valley (Giambelluca *et al.* 1986). The USAR on Oahu is located within Pearl Harbor on the dry leeward side of the island in an area than has on average 600 mm rainfall per year.

The four Hawaii Island parks are in relatively low rainfall areas with constant warm temperatures and pronounced daily wind patterns of land and sea breezes (Blumenstock and Price 1967). KAHO has a mean annual rainfall of approximately 600 mm and a seasonal climate with higher rainfall during summer months (Canfield 1990a). The climate of PUHO is similar to that of KAHO, with mean annual precipitation of 659 mm. PUHE is located within one of the four rainfall minima of the island of Hawaii and receives <250 mm of rain annually (Giambelluca *et al.* 1986). Because ALKA covers a large linear coastal transect along West Hawaii, the rainfall pattern is variable.

The climate of Guam and the Northern Marianas (CNMI), including Saipan, is warm, wet, and tropical. Temperature varies between 90 and 70° F. Relative humidity is high, often exceeding 80% and seldom falling below 50%. The rainfall pattern is strongly seasonal with a wet season from July to November and a pronounced dry season from December to June. Average annual rainfall of the Marianas is 2,160 mm (85 in) (Baker 1951), and on Guam the annual mean is 2,175 mm (Mueller-Dombois and Fosberg 1998). Typhoons are yearly events, which occur during the monsoonal wet season. Trade winds blow from the northeast, but easterly and southeasterly winds prevail during several months in the spring (Baker 1951). Because Guam and the Marianas are relatively low islands, there is no pronounced rain shadow effect, and leeward shores are not drier than those of the windward sides (Mueller-Dombois and Fosberg 1998).

NPSA has a warm tropical climate with little seasonal variation in temperature. Rainfall is high in the four units of the park. On Tutuila, annual rainfall averages 3,200 mm (at the airport), and may be even higher on the upper mountain slopes within the park. Rainfall is seasonal with greater monthly means from October to May and a dry season from June to September. Hurricanes are occasional but not annual events (Whistler 1994). Tau Island unit is only about 96 km (60 miles) east of Tutuila and shares its warm and wet tropical climate. Tau average rainfall is more than 2,500 mm per year and is highest in December. The dry season is June to September, and droughts sometimes occur on the island (Whistler 1992).

CONCEPTUAL ECOLOGICAL MODELS

The components of the conceptual ecological model for terrestrial vertebrates are outlined in Figure 2.

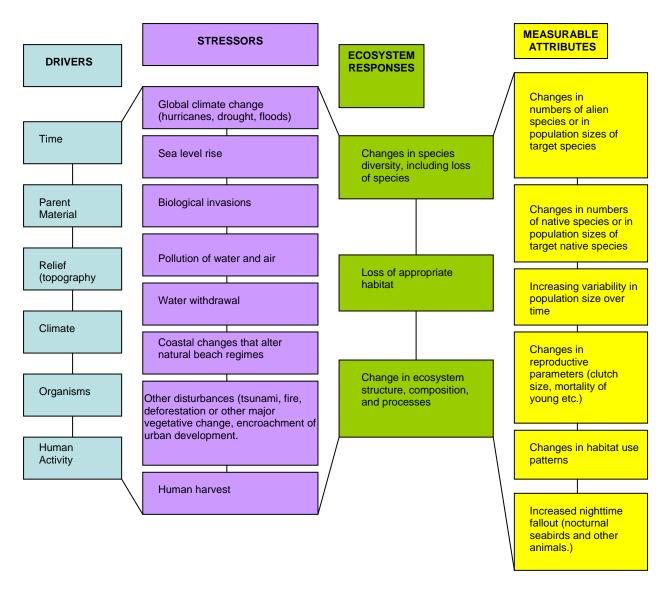


Figure 2. Conceptual ecological model for terrestrial vertebrate fauna in the Pacific Island Network.

DRIVERS

Drivers are major forces of ecosystem change. Jenny (1980) identified six major categories of ecological drivers time, parent material, relief/topography, climate, organisms, and human activity. Changes in magnitude or direction of these drivers result in changes in the biological community, including changes in species composition, diversity or patterns in population abundance or dispersion. Human activity can significantly alter the nature or magnitude of a Natural Driver, creating an unnatural type or level of stress on a community and subsequent changes in its structure or function.

STRESSORS

Stressors are physical, chemical or biological perturbations to a system resulting from the model drivers. Global climate change, sea level rise, biological invasions (including predatory invasives, competition, facilitating the spread of pathogens, and impacts of invasive species on habitat), pollution, water withdrawal, coastal changes, other disturbances or catastrophes (tsunami, fire, wholesale conversion or loss of vegetation such as from deforestation or conversion to agricultural use), habitat restoration, and human harvest were identified as stressors. Stressors identified in the conceptual model have differing local and park effects on terrestrial fauna throughout the network. Our assessment of these effects attempted to anticipate the most serious impacts, particularly to native fauna.

The *change in climate patterns* over various time scales may have a variety of effects on existing ecosystems and their components. Among these are increased frequency and severity of weather catastrophes such as droughts, floods, hurricanes, and ENSO (El Nino- Southern Oscillation) events. One or a series of these severe events can cause precipitous declines, particularly in already-small populations of native terrestrial species. Global climate change and associated severe weather events could change sea surface temperatures, impacting food supply for marine birds known to be present at HALE, HAVO, NPSA, and possibly presentat KAHO, PUHO, KALA, and WAPA. Severe weather events such as storms and floods during the breeding season can impact ground and open-cup nesting birds in HALE, HAVO, KAHO, KALA, NPSA, and possibly WAPA.

Sea level rise may result in loss of wetland and shoreline habitat for water birds at KAHO, habitats adjacent to ALKA and wetland birds at AMME. Migratory shorebirds, which currently use shorelines in all network parks, may lose feeding and roosting habitat. Shoreline-nesting seabirds at KAHO and possibly KALA could lose nesting habitat. Sea turtles may lose nesting and/or basking habitat at HAVO, NPSA, KALA, KAHO, ALKA, and PUHO. Monk seal pupping beaches may be lost at KALA.

Biological invasions can impact native animals by predation; competition; facilitating the introduction of alien diseases and parasites; and displacing food supply, roost sites or other important habitat components. Invasive species may be even more damaging to native species and ecosystems on a global scale than the loss and degradation of habitats.

Pollution from nearby harbors or upslope areas may degrade waterbird and migratory bird habitat. The AMME wetland, habitat for endangered Nightingale Reed Warbler, is threatened by water quality degradation. KAHO, PUHO and PUHE wetland habitats, used by endemic water birds and migratory species, are threatened by pollution from upslope or adjacent harbors. Pollution appears to be a minimal problem at NPSA at this time (Monello, pers.comm.).

Water withdrawal causes reduction and degradation of wetland and estuarine habitat, and could change soil moisture, and thus, vegetative cover. PUHE wetland may be threatened by upslope dewatering. A drop in the water table due to upslope water withdrawal may impact endemic water birds and some shorebirds.

Coastal changes include construction or mining that alter natural beach regimes, as well as encroaching urbanization or heavy use of areas by humans. Increased human use disturbs shorebirds, basking and nesting turtles, and basking monk seals within parks. Shorelines outside

parks are often heavily used and impacted by pets and lights. Thus, the more protected confines of the network's national parks may become increasingly important refugia for these animals.

Other disturbances or catastrophes include tsunami, fire, wholesale conversion or loss of vegetation from deforestation or conversion to agricultural use and urban encroachment.

These large-scale, often sudden changes have caused loss of habitat for Bulwer's petrels at HAVO (subsidence associated with a tsunami), and loss of forest for native birds and reptiles from fire (HAVO, HALE, WAPA). Adjacent deforestation outside HAVO has further reduced forest bird habitat. Loss or fragmentation of less disturbed buffer zones outside all parks has accelerated the invasion of alien plants and predators.

Human harvest includes both legal and illegal methods. Two species of fruit bats, the Pacific pigeon (*Ducula pacifica*) and the Many-Colored Fruit Dove (*Ptilinopus perousii*) were harvested at NPSA for subsistence. Since the 1990's there has been a ban on hunting these birds and fruit bats. Poaching does not seem to be having an impact on the bat population.

ECOSYSTEM RESPONSES

Ecosystem responses to stressors were identified as follows:

Changes in species diversity include native, alien, and culturally significant species, total loss (extinction or extirpation) of species, and changes in genetic diversity.

Habitat Loss. Rises in sea level may result in the loss of wetland habitat for water birds and migratory birds, and loss of nesting habitat for shoreline nesting seabirds. Fire may also eliminate habitat for native forest birds and reptiles.

Changes in ecosystem structure, composition and processes. Changes encompass various forms of habitat degradation. For some species, these changes will be tolerable; for others, they will not be. Invasion of alien, fire-adapted grasses has changed the fire regime, thus further altering plant composition, and possibly nutrient cycling, in low and mid-elevation grasslands at HAVO, HALE and WAPA. Fauna impacted by these changes include Nene and potentially any native invertebrates still present. Decline of dominant tree species in forest habitat through fire, disease or selective harvest may affect birds and bats. The loss of native food plants and changes in nutrient cycles impact food availability and quality for Nene.

MEASURABLE ATTRIBUTES

Attributes are any living or nonliving feature or process of the environment that can be measured or estimated and that provide insights into the state of the ecosystem. Measurable attributes that were identified in the vertebrate fauna conceptual model are described below.

Changes in abundance of target alien and native species, including culturally significant species. Culturally important species include Hawaiian aumakua or family deities such as Pueo (HAVO, HALE, KAHO), Io (HAVO, PUHO), and gecko or mo`o (probably in all parks). Seabirds were formerly a food source mentioned in many historic accounts; Hawaiian honeycreepers were harvested for feathers (stories of bird catchers), and Nënë were used as watch dogs. These latter examples may have occurred and ended early enough that few modern cultural ties to these animals and practices now exist. Other targeted species could include highly invasive aliens being controlled by parks, threatened or endangered native species, more

common native species that serve as indicators of system change, or keystone species that support native systems.

Population Counts. For threatened, endangered, rare or indicator/keystone species, population counts or estimates may be possible and desirable. Changes in variability of populations over time may be indicative of negative ecosystem responses. However, in all cases, changes must be distinguishable from any "normal" population fluctuations.

Changes in habitat use patterns. Native species may shift habitats in response to aliens, climate change, or habitat degradation. In some cases, species remain in marginal habitat only. Presence/absence monitoring may be appropriate here in some cases.

Changes in reproductive parameters such as clutch size, hatching success, juvenile mortality.

Changes in demography could serve as an early warning of reproductive failure, particularly in long-lived species with lower reproductive rates. However, it must be possible to distinguish ages or age classes.

Changes in nighttime fallout of seabirds and possibly other nocturnal animals are indicative both of population status in colony areas (e.g., Kauai fallout data) and of problems with light pollution.

PARK AND NETWORK-WIDE ISSUES

COASTAL CHANGES (INCLUDING CLIMATE AND SEA LEVEL RISE)

Sea surface temperature changes may impact food supply for marine birds at HALE, HAVO, NPSA, and possibly at KAHO, PUHO, and WAPA where seabird presence is not well documented. Hodges (pers. comm.) reported a drop in fledging success of Hawaiian Petrels (*Pterodroma sandwichensis*) in a year with a severe El Nino/Southern Oscillation (ENSO) event compared with a multiple year mean, suggesting a possible impact to food resources for breeding petrels.

Severe weather events such as storms and floods during the breeding season particularly can impact ground (Nene, Pueo, stilt) and open-cup nesting birds (forest birds). Parks with these resources are: HALE, HAVO, KAHO, KALA, NPSA, ALKA and possibly WAPA. WAPA has concerns with weather patterns and rainfall associated with El Nino affecting terrestrial fauna. There maybe many other potential impacts of climate change on vertebrates, though nothing is available in the literature.

Sea level rise may result in the loss of wetlands and shoreline habitat for water birds at KAHO, habitats adjacent to ALKA, and wetland birds (nightingale reed warbler) at AMME. Migratory shorebirds, which currently use shorelines in all network parks, may lose feeding and roosting habitat. In the Asan unit of WAPA there are small seeps and springs near cliff bottoms that are associated with wetlands which are of concern. Shoreline-nesting seabirds, such as shearwaters at KAHO and possibly KALA, could lose nesting habitat due to sea level rise. Sea level rise could also cause turtles to lose habitat, i.e. nesting beaches for hawksbill turtles at HAVO and green sea turtles at NPSA; loss of basking beaches for green sea turtles at HAVO, KAHO, and PUHO. Monk seal pupping beaches may be lost at KALA if the shallow, protected pools used by young pups are submerged by rising sea water.

Water Withdrawal. PUHE wetland may be threatened by use of water by upslope developments. The drop in the water table due to upslope water withdrawal may reduce freshwater inputs at KAHO, impacting endemic water birds and some shorebirds.

Other disturbances or catastrophes (tsunami, fire, extensive vegetative changes, urban encroachment). These large-scale, sudden changes have caused loss of habitat for Bulwer's petrels at HAVO (subsidence associated with a tsunami), and loss of forest for native birds from fire (HAVO, HALE, WAPA). Adjacent deforestation outside HAVO has further reduced forest bird habitat. Loss or fragmentation of less disturbed buffer zones outside all parks has accelerated the invasion of alien plants and predators.

Increased human use could cause disturbance to shorebirds, basking and nesting turtles, and basking monk seals within parks. Perhaps more significantly, shorelines outside parks are often heavily used or impacted by nearby development that brings large numbers of people, as well as pets and lights into proximity of coastal wildlife. Thus, the protected confines of the national parks may become increasingly important refugia for these animals.

BIOLOGICAL INVASIONS

Predatory invasive species. Rats and feral cats are probably the two most serious predatory threats to native avifauna shared by all network parks. In addition, there are well-established populations of mongooses on most of the Hawaiian Islands and brown tree snakes on Guam. Water birds and ground nesting seabirds at KAHO are threatened by mongooses, rats and feral cats. Hawaiian Petrels, Nene and forest birds at HALE and HAVO also are impacted by these same predators. Rat impacts have been documented on 'Elepai'o at HAVO (Sarr et al 1998.). Rats and feral cats may prey on native forest birds and seabirds at NPSA, WAPA and possibly AMME, and on shorebirds at all parks. Feral pigs, present in most Hawaii parks, as well as in NPSA and WAPA, prey on ground nesting birds, eggs and chicks. Loose dogs pose occasional threats to wildlife at all parks. Ants threaten some native vertebrates: biting fire ants on off shore islets of Oahu damaged the feet of Wedge-tailed shearwater chicks. All parks with native birds and reptiles are at risk from the potential establishment of the brown tree snake, with the nightingale reed warbler at AMME probably at highest risk due to its small population size and proximity of the park habitat to a harbor which could act as a conduit for snake introductions from nearby Guam. Besides rats, feral cats, and humans, there are currently no known established threats to birds or bats in NPSA. Hunting has been banned on the island and poaching does not seem to have an effect on the bats.

Competition from invasive species. Competitive effects on native terrestrial animals are poorly documented. Scott et al. 1986, suggest competition between Japanese White-eye and Elepaio for insect food resources and between Japanese White-eye and Γiwi for nectar food resources. The Polynesian-introduced mourning gecko is being displaced by a recently introduced lizard on Oahu, although the mechanism for this displacement is not known. (E. Campbell, pers. comm.)

Facilitating spread of diseases or pathogens. Mosquitoes and alien birds are responsible for the establishment and spread of avian diseases including malaria and pox in Hawaii. Feral pigs create additional mosquito breeding sites by felling tree ferns and eating the trunk's interior; thus, disease is more prevalent in forest areas with alien pigs (Atkinson, unpublished report). Avian disease may have caused or contributed to the extinction of several

endemic Hawaiian birds, and currently it threatens or limits many surviving species in HAVO, HALE, and possibly KALA. The presence of avian malaria (Plasmodium spp) was documented in birds sampled from Tutuila, American Samoa (Jarvi etal 2003). Further study is needed to determine its overall effects on current bird populations in America Samoa because of the lack of extensive bird extinction records. Stow-away vectors and imported alien birds and possibly other animals are potential sources of new diseases to be introduced.

Impacts of aliens on important habitat components. Habitats for native species have been degraded by feral ungulates at HAVO, HALE, KALA, NPSA WAPA and ALKA. Impacts of rats on native plant communities, documented at HAVO in recent broadcast toxicant work, and at HALE in a food habit study (Cole et al, 1993), probably affect all parks except USAR. However, little information on the impacts of rats on native vertebrates has been described. Invasive alien plants appear to have displaced some native Nene food plants.

POLLUTION

AMME: Wetlands at AMME which are habitat for endangered Nightingale Reed Warbler, are threatened by water quality degradation, flood control and run off from town sewage, and encroaching development.

KAHO: there are numerous anchialine ponds, two fish ponds, and a large embayment in this park located down slope of a growing industrial area. Leaching from upslope cesspools and septic tanks and industrial development contributes to bacterial contamination and nutrient loading of these resources. A small boat harbor is located between park units and is a source of petroleum, heavy metals, and phosphates from wash water. The threat of sedimentation onto the coral reef is increased by pond restoration activities, erosion of the sandy shoreline, and dredging and/or expansion of the harbor. The rising sea level due to global warming will also contribute to erosion of the shoreline at KAHO.

KALA Feral pigs, deer and cattle degrade stream resources in and around this park. This adds to the stresses caused by diversion and input due to agriculture and urban development. Village areas in the park may have issues with the leaching of untreated sewage and PCBs.

NPSA: In the Ofu unit there is a closed dump site that continues to percolate water of unknown quality into the marine environment. Pollution appears to be a minimal problem at NPSA at this time (Monello, pers.comm.)

PUHE: A recreational harbor exists adjacent to the park and a commercial shipping facility on the other side of that. These facilities contribute to the likelihood that marine recreation activities such as fishing and diving will increase leading to a subsequent increase in fuel spills, pollution, and alteration of the substrate. Dirt biking along coral flats and stream beds, municipal and industrial wastewater discharges, residential and resort development, and land-based recreational activities all contribute to erosion and pollution of the near shore water. A stream originating upslope from the park is influenced by diversion, storm water runoff, and erosion of the top soil. There may also be a marsh area which is uncharacterized.

PUHO: Urban development up-slope from the park, and the high level of tourism is negatively impacting water quality of springs, fishponds, tide pools, and the near shore marine environment. Inland ponds that exist are vulnerable to sedimentation and eutrophication. A submerged, natural discharge occurs presumably through a lava tube which is unique to this park

and could be a conduit for contaminants originating upslope. It is expected that the rising sea level, due to global, warming will eventually flood this low coastal park.

USAR: located in Pearl Harbor where industrial and agricultural pollution are long-standing issues, have contributed to the degradation of this estuary.

WAPA: The Asan unit has wetlands which are susceptible to contamination from unsewered residential areas and flooding events which bring soil and agricultural runoff.

HABITAT RESTORATION

Habitat restoration includes forest, wetland, and grassland habitats, and potentially other habitat types within the network. This category also includes community "rehabilitation," which attempts to create somewhat novel habitats using native species adapted to an alien disturbance regime (e.g., fire) (Tunison & Loh, 1995). Wetland habitat restoration to aid recovery of endangered Hawaiian water birds is in the planning stages at KAHO. Other habitat restoration work has been aimed primarily at native plant communities (various forest types, coastal strand, etc. at HAVO), and impacts on native terrestrial vertebrates have not been documented. The exception is native forest bird monitoring in recovering forest at HALE. Fences built to exclude feral ungulates also catch nesting seabirds and bats at HALE and HAVO. Sub alpine fence inspections at HAVO note these fence caught birds and include searches for downed birds. ALKA will encourage communities to engage in habitat restoration and can support existing community efforts aimed at habitat restoration along the trail. Strategically located restoration projects bordering NPS park units will benefit conservation efforts within parks. Furthermore, NPS units can teach community volunteers in the park how to inventory, monitor and restore native habitats. These skills could then be applied to trail and other areas adjacent to the park.

HUMAN HARVEST

Both species of fruit bats at NPSA and the Pacific pigeon (Ducula pacifica) and the Many-Colored Fruit Dove (Ptilinopus perousii) were harvested for subsistence. Since the 1990's there has been a ban on hunting these birds and fruit bats. Although poaching of bats does occur, it does not seem to be having an impact on the bat population. Over fishing of near shore fish threatens the sustainability of resources and affects ecosystem balance along the ALKA trail corridor.

	Coastal	Biological Pollution		Habitat	Hι
	Changes	Invasions	Pollution	Restoration	На
ΔΙΚΔ	Y	Y		Y	

Table 1: Comparing Network-wide Issues Affecting Terrestrial Vertebrate Fauna by Park

	Coastal Changes	Biological Invasions	Pollution	Habitat Restoration	Human Harvest
ALKA	X	X		X	X
AMME	X	X	X		
HALE	X	X		X	
HAVO	X	X		X	
КАНО	X	X	X	X	
KALA	X	X	X		

	Coastal Changes	Biological Invasions	Pollution	Habitat Restoration	Human Harvest
NPSA	X	X	X		X
PUHE	X	X	X		
PUHO	X	X	X		
USAR	X		X		
WAPA	X	X	X		

Table 2. Critical Resources and Stressors identified by the Vertebrate Fauna Workgroup

	Critical Resources				Stressors		
	T & E Species	Rare Species	Species w/ Cultural Significance	Invasive Alien Species	Biodiversity Loss	Climate Change (sea level rise)	Fire or Altered fire regimes
ALKA	P	P	P	P	P	P	P
AMME	S	S	S	S	S	S	
HALE	S	S	S	S	S	S	S
HAVO	S	S	S	S	S	S	S
КАНО	S	S	S	S	S	S	S
KALA	S	S	S	S	S	S	P
NPSA	S	S	S	S	S	S	
PUHE	S	S	S	S	S	S	S
PUHO	S	S	S	S	S	S	S
USAR		S					
WAPA	S	S	S	S	S	S	S

P= Potential S= Self Identified

MONITORING

<u>ALKA</u>

There is no monitoring of vertebrate fauna at ALKA at this time. However, because the trail passes through national parks, portions of it may have been included in various park inventory or monitoring programs.

ALKA Monitoring Needs: Basic inventories of terrestrial vertebrate fauna.

<u>AMME</u>

A wetlands survey was conducted in 2001 by Raulerson but there in no final report. This included a predator study for the endangered warbler, GIS mapping, and inventory of plant species. An ornithological survey was done in the 1979 by the Army Corp of Engineers of wetlands in Guam, Saipan, Tinian and Pagan. (Tenorio, J.C. & Associates, 1979). Currently birds are monitored by the Division of Fisheries & Wildlife, including the Christmas Bird Counts.

AMME Monitoring Needs: endangered birds; inland mangrove wetland hydrology; mangrove forest, wetland assessment and restoration is needed at AMME. Basic inventories of terrestrial vertebrate fauna.

HALE

The park was included in the USFWS' Hawaii Forest Bird Survey, which collected data on forest and upland birds, ungulate activity, vegetation, and incidental bird sightings.

The park participates in supra-annual forest bird counts conducted by the State and cooperators. This effort uses a subset of the former Hawaii Forest Bird Survey transects.

The Kipahulu Interdisciplinary Study (1983-84), included forest bird counts (P. Banko) and rat trapping on 500m transects (C. Stone). The subsequent Kipahulu Pig Research (1985-88) focused on ungulate activity.

In the Crater District, park staff monitors population trends, dynamics, threats, etc., of ground-nesting endangered birds (Nene and Uau). The effects of the removal of feral animals on Uau populations are also monitored.

Forest bird populations are monitored in recovering rain-forest areas. This is the sole instance in the network of native vertebrate monitoring in response to habitat restoration.

The park monitors and removes introduced alien mammals.

HALE Monitoring Needs: T & E species, seabirds, forest birds and bats.

HAVO

Two dominant vertebrate monitoring projects on going at HAVO are the Nene monitoring project which began in the early 1970's, and Dark-Rumped Petrel monitoring on Mauna Loa

which began in the mid 1990's. The Nene (Hawaiian Goose) monitoring program provides population trend information for Nene in and adjacent to HAVO.

Nesting colonies of Hawaiian Petrels are monitored for nest success and to access if predator trapping efforts are affective.

Removal of feral ungulates (i.e, pigs and goats) was successfully completed during the 1970's through the 1990's. Monitoring for ingress of animals into fenced units within the park is carried out regularly to keep feral ungulate populations at zero within the park.

Forest bird surveys in HAVO provided critical information on bird distribution and densities along moisture and elevational gradients. HAVO is uniquely situated along a moisture gradient (<1000 - >4000 cm annual rainfall) ranging from wet to mesic to dry forests. Monitoring bird populations along this gradient provided insight into ecological dynamics and population responses not available elsewhere. The park provided the only recent source of forest bird data along an elevational gradient (2000 – 7000 ft.; East Rift Zone to Mauna Loa Strip transects). However, this monitoring ceased in the mid 1990's. A long term monitoring program is essential to determining population fluctuations and changes, and species' range contractions/expansion.

HAVO Monitoring Needs: Rare animal species, including endangered species and species examples of evolutionary processes; forest birds, procellarids and Nene.

KAHO

Monitoring of water bird population, nesting, and fledgling success is on going at KAHO.

Semi-annual statewide waterbird counts are conducted at KAHO, in cooperation with the Division of Forestry and Wildlife, State of Hawaii.

Predator control monitoring is on going at KAHO to access the effectiveness of control methods.

KAHO Monitoring Needs: endemic water birds.

KALA

Feral ungulate removal and monitoring from the Puu Alii plateau (State Natural Area Reserve) adjacent to Kalaupapa, to prevent ingress of feral ungulates into the park.

Beaches at Kalaupapa are monitored for Hawaiian monk seal use.

Goats, pigs, deer removal and monitoring are on going on the main peninsula of KALA.

KALA Monitoring Needs: abundance and distribution of all bird species throughout the park, forest bird trends, and procellarids.

NPSA

American Samoa, Department of Marine and Wildlife Resources monitor bird and fruit bat populations territory-wide with some stations located within the NPSA.

A seabird study was completed in 2003 at NPSA. The purpose of the project was to assess the size and extent of resident seabird populations for NPSA. (2003, O'Connor & Rauzon).

Feral pig control efforts are ongoing at NPSA. There are ten activity transects on Tutuila and three transects on Ta`u. Snaring and activity transect data is collected. The goal is to survey all transects at least once a year and areas of concern more often. Snares are present throughout the Park.

NPSA Monitoring Needs: fruit bats, sheath tailed bats, rainforest birds, Tahitian petrels and seabirds.

<u>PUHE</u>

There is no known terrestrial vertebrate monitoring at PUHE.

PUHE Monitoring Needs: Unknown

PUHO

No known terrestrial fauna monitoring has been done or is ongoing at this time at PUHO.

PUHO Monitoring Needs: T & E species, sensitive, native, and exotic animals

WAPA

In lands adjacent to the WAPA, USGS and other organizations are working to prevent the brown tree snake from expanding its range and establishing itself in new areas. Using visual and trapping methods (including scent by Jack Russell Terriers) to capture snakes to prevent them from spreading to other islands or near habitats designated for endangered or threatened species.

WAPA Monitoring Needs: species in limestone forests and tropical savannas. Basic inventories of terrestrial vertebrate fauna are also needed for WAPA.

CONCLUSIONS

Native terrestrial vertebrates within PACN parks represent the remains of larger faunal assemblages that were lost both prehistorically and historically due to human influences. In most parks, the initial impact from humans was direct depredation, primarily for food. As is the case elsewhere, historic and current declines result primarily from the impacts of alien species and habitat loss. As a result of these declines, all network parks with known terrestrial vertebrates (i.e., excluding ALKA and USAR) may or do contain at least one federally endangered species. The proportion of native terrestrial fauna that is imperiled (federally threatened, endangered, or a candidate for listing) is startlingly high in some parks: 26% of HAVO's documented native fauna. Equally astounding is the number and proportion of alien terrestrial vertebrates. All network parks share roof rats and feral cats, probably the two most universal alien species on islands. One park, WAPA, has the brown tree snake, one of the most destructive alien vertebrates recorded. AMME, also in the Northern Mariana islands, probably has incipient populations of this species. The small wetland at AMME, if protected from the snake, may represent an opportunity to help prevent the nearly absolute loss of native land birds on Saipan that occurred on Guam. Similarly, the more pristine forests and coastal strand in NPSA represent opportunities for in situ conservation that were lost in the Hawaiian Islands. Early

aggressive action to identify and contain invasive aliens will help conserve the largely intact ecosystems and their native vertebrate fauna. However, both AMME and NPSA have a small staff base and limited funding. In the Hawaiian parks, restoration and rehabilitation of vegetation communities is underway and may expand habitat for some native birds and the bat. Partnerships with neighboring land owners are an effective tool used with increasing frequency in the Hawaii. Additionally, while some species will respond to habitat recovery and rehabilitation, other natives will need concentrated efforts to further elucidate and address causes of decline.

Native vertebrates in all PACN parks are at risk from alien threats not yet on the islands, including disease and the brown tree snake. Addressing the threat of these aliens will require action well outside park boundaries and sustained support of and/or collaboration with others. The PACN I&M program could play an important role in this effort by carefully documenting resources at risk and the impact of established invasive alien species.

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LITERATURE REVIEWED

- Atkinson, Carter. No Date. Study Plan: Effect of feral pig exclosures on the distribution and abundance of Culex quinquefasiatus in Olaa forest: National Biological Survey, National Wildlife Health Center.
- Baker, R. H. 1951. The avifauna of Micronesia, its origin, evolution, and distribution. University of Kansas Publications, Museum of Natural History 3(1): 1-359.
- Blumenstock, D. I., and S. Price. 1967. Climates of the states: Hawaii. Environmental Science Data Service, Climatology of the United States, No 60-51. U. S. Government Printing Office, Washington, D. C. 27 pp.
- Canfield, J. 1990a. Description and map of the plant communities of Kaloko-Honokohau National Cultural Park. Cooperative National Park Resources Studies Unit Technical Report 73. University of Hawaii at Manoa, Department of Botany, Honolulu, Hawaii.
- Cole, F.R., Loope, Lloyd L., Medeiros, Arthur C., Raikes, Jane A., Wood, Cynthia S., Anderson, Laurel J. 1995. Ecology of introduced game birds in high-elevation shrubland of Haleakala National Park CPSU Technical report 96, Cooperative National Park Resources Studies Unit Technical Report Series: Cooperative National Park Resources Studies Unit, University of Hawai`i at Manoa.
- Giambelluca, T. W., M. A. Nullet, and T. A. Schroeder. 1986. Rainfall atlas of Hawaii. Report R76. Water Resources Research Center, University of Hawaii at Manoa with the cooperation of the Department of Meteorology. State of Hawaii, Department of Land and Natural Resources, Division of Water and Land Development, Honolulu, Hawaii.
- Jarvi, S., Farias, M., Baker, H., Friefeld, H., Baker, P. Van Gelder, E., Massey, J.G., Atkinson, C. 2003. Conservation Genetics, Vol.4, iss.5, pp 629-637.
- MacDonald, G. A., and A. T. Abbott. 1970. Volcanoes in the sea; the geology of Hawaii. University of Hawaii Press, Honolulu, Hawaii.

- Moore, R. B., D. A. Clague, M. Rubin, and W. A. Bohrson. 1987. Hualalai volcano: a preliminary summary of geologic, petrologic, and geophysical data. Pp. 571-585 in R. W. Decker, T. L. Wright, and P. H. Stauffer (editors). Volcanism in Hawaii, Vol. 1. U. S. Geological Survey Professional Paper 1350. U. S. Government Printing Office, Washington, DC.
- Mueller-Dombois, D., and F. R. Fosberg. 1998. Vegetation of the tropical Pacific islands. Springer-Verlag, New York.
- National Park Service, 1980 "NPS Floodplain Management and Wetland Protection Guidelines" (45 Fed. Reg. 35916, minor revisions in 47 Fed. Reg. 36718).
- O'Connor, Paul J., Rauzon, Mark J., 2003. Inventory and Monitoring of Seabirds in National Park of American Samoa. PCSU Technical Report 132, University of Hawaii at Manoa.
- Sarr, Zee, Shema, Nicholas P., Stone, Charles P. 1998. Nesting success and population status of the Elepaio (Chasiempis sandwichensis) in the Mauna Loa Strip section of Hawaii Volcanoes National Park PCSU Tech Report 118: University of Hawaii at Manoa.
- Scott, J. Michael, Mountainspring, Stephen, Ramsey, Fred L., Kepler, Cameron B. 1986. Forest bird communities of the Hawai`ian islands: their dynamics, ecology, and conservation, Studies in Avian Biology: Cooper Ornithological Society.
- Tenorio, J.C. and Assoc. 1979. Ornithological survey of wetlands in Guam, Saipan, Tinian, and Pagan: Corps of Engineers. Pacific Ocean Division.
- Tunison, J. Timothy, Loh, R.L., Leialoha, J.A.K. 1995. Fire effects in the submontane seasonal zone, Hawai`i Volcanoes National Park CPSU Technical report 97: Cooperative National Park Resources Studies Unit, University of Hawai`i at Manoa.
- Tunison, J. Timothy, Loh, Rhonda K., Pratt, Linda W., Kageler, V. Anne Dina. 1994. Early succession in pig-disturbed mountain parkland, Hawai`i Volcanoes National Park CPSU Technical report 89, Cooperative National Park Rescources Studies Unit Technical Report Series: Cooperative National Park Resources Studies Unit, University of Hawai`i at Manoa.
- Uyehara, Kimberly J. 1997. Why People and Wetlands Need One Another, A Case Study of the American Memorial Park Wetland & Mangrove Forest Saipan, Commonwealth of the Northern Marianas, Northern Mariana College, Natural History of the Mariana Islands.
- Vitousek, Peter. 1995. The Hawaiian Islands as a Model System for Ecosystem Studies. Pacific Science, Vol 49, no.1:2-16.
- Whistler, W. A. 1992. Botanical inventory of the proposed Tau unit of the National Park of American Samoa. Cooperative National Park Resources Studies Unit Technical Report 83.University of Hawaii at Manoa, Department of Botany, Honolulu, Hawaii
- Whistler, W. A. 1994. Botanical inventory of the proposed Tutuila and Ofu units of the national Park of American Samoa. Cooperative National Park Resources Studies Unit Technical Report 87. University of Hawaii at Manoa, Department of Botany, Honolulu, Hawaii.

APPENDIX A: SUMMARY OF TERRESTRIAL VERTEBRATE FAUNA

Tables below are summaries of terrestrial fauna for each of the Pacific Island Network Parks, listed as "Present in Park" in NPSPP.

ALKA: Not much information is known about the terrestrial fauna at ALKA. Sections of the ALKA trail pass through other National Park boundaries and may include terrestrial fauna listed in those parks.

AMME: Migratory bird species can be seen along the coastal sections of the park. The small mangrove swamp within the memorial is an excellent habitat for native birds. Collared kingfishers, Micronesian honeyeaters, bridled and golden white-eyes, rufous fantails, and island swiftlets are often seen here. Two resident birds, the Marianas form of the common moorhen and the nightingale reed warbler are endangered. The tidal flats between the "peninsula" and the east park boundary are among the best places on Saipan to see migrant shorebirds. Known mammals include feral cats and dogs (AMME staff, pers. comm.).

Table 3 V	^z ertebrate _.	fauna a	locumented	at AMME
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Standard Scientific Name	Standard Common Name
Suncus murinus	House shrew
Acrocephalus luscinia	nightingale reed-warbler
Aerodramus vanikorensis	gray swiftlet
Aplonis opaca	Micronesian starling
Cleptornis marchei	golden honeyeater
Gallicolumba xanthonura	white-throated ground-dove
Gygis alba	white tern
Halcyon chloris	white-collared kingfisher
Ixobrychus sinensis	chinese bittern
Myzomela rubratra	Micronesian honeycreeper
Perochirus ateles	Fragile micronesian gecko
Ptilinopus roseicapilla	marianas fruit-dove
Rhipidura rufifrons	rufous-fronted fantail
Zosterops conspicillatus	bridled white-eye

HALE: The west crater rim, especially near the summit, provides most of the remaining and best protected habitat for the endangered Hawaiian Petrel (*Pterodroma phaeopygia sandwichensis*). The crater is also one of the major sites in the Hawaiian Islands where the endangered Hawaiian goose (*Branta sandvicensis*), has been reintroduced from captive-bred populations. Both species are depredated by mongooses, feral cats, feral dogs and rats. Park predator control programs have helped improve the status of theses two species. In general, introduced herbivores, primarily feral goats (*Capra hircus*), cattle (*Bos taurus*) and sheep (*Ovis aries*), were recognized as the primary obstacle to preservation of the native biota. Other threats to the resources include of feral goats, feral pigs, Axis deer, mongooses, three species of rats, feral cats, alien bird species, and numerous alien invertebrate species including predatory yellow-jacket wasps and several species of ants. Fencing of the crater district has helped reduced the natural resources destruction by feral ungulates. Eight of HALE's native birds are federally threatened or endangered.

Table 4 Vertebrate fauna documented at HALE

Standard Scientific Name	Standard Common Name
Axis axis	Axis deer
Bos taurus	domestic cattle

Canis familiaris	domestic dog
Capra hircus	goat
Felis silvestris	domestic cat
Herpestes auropunctatus	mongoose
Lasiurus cinereus semotus	Hawaiian hoary bat
Mus musculus	house mouse
Rattus exulans	Polynesian rat
Rattus norvegicus	Norway rat
Rattus rattus	black rat
Sus scrofa	pig
Acridotheres tristis	common myna
Alauda arvensis arvensis	Sky Lark
Alectoris chukar	chukar
Anas wyvilliana	hawaiian duck, koloa
Anous minutus melanogenys	Hawaiian noddy, black noddy
Asio flammeus sandwichensis	Hawaiian short-eared owl
Branta sandvicensis	Hawaiian Goose, Nene
Bubulcus ibis	cattle egret
Callipepla californica	California quail
Cardinalis cardinalis	northern cardinal
Carpodacus mexicanus	house finch
Cettia diphone	japanese bush-warbler
Columba livia	rock dove
Francolinus pondicerianus	gray francolin
Fregata minor palmerstoni	great frigatebird
Garrulax canorus	melodious laughing thrush
Geopelia striata	zebra dove
Hemignathus lucidus affinis	Maui nukupu'u
Hemignathus virens wilsoni	Maui 'amakihi
Heteroscelus incanus	wandering tattler
Himatione sanguinea sanguinea	`apapane
Leiothrix lutea	red-billed leiothrix
Lonchura malabarica	warbling silverbill
Lonchura punctulata	nutmeg mannikin
Loxops coccineus ochraceus	Akepa (Maui)
Mimus polyglottos	northern mockingbird
Nycticorax nycticorax hoaetli	Black-crowned night heron
Oceanodroma castro	band-rumped storm-petrel
Palmeria dolei	'akohekohe, crested honeycreeper

Paroreomyza montana	maui creeper
Paroreomyza montana newtoni	Lanai creeper, Maui creeper
Passer domesticus	house sparrow
Phaethon lepturus dorotheae	white-tailed tropicbird
Phasianus colchicus	ring-necked pheasant
Pluvialis fulva	Pacific Golden Plover
Pseudonestor xanthophrys	maui honeycreeper, maui parrotbill
Pterodroma sandwichensis	Hawaiian petrel
Puffinus auricularis	'a'o, manx, newell's townsend's shearwater
Streptopelia chinensis	spotted dove
Tyto alba	common barn-owl
Vestiaria coccinea	'i'iwi
Zosterops japonicus	Japanese white-eye
Lampropholis delicata	garden skink, metallic skink
Lepidodactylus lugubris	mourning gecko
Ramphotyphlops braminus	Brahminy blind snake
Bufo marinus	giant toad, marine toad
Rana catesbeiana	Bullfrog

HAVO: Four of the Park's resident terrestrial vertebrate species are endangered or threatened: Nënë, Hawaiian Petrels, Hawksbill Sea Turtle, Hawaiian Hoary Bat, and Hawaiian Hawk. The threatened Newell's Shearwater may occur in the park. Non-native vertebrates consist of feral goats, feral pigs, mouflon sheep, mongooses, three species of rats, feral cats, and 22 alien bird species. An additional four native forest birds have been lost in the past thirty years (three extirpations Hawaii Akepa, Hawaii Creeper and Akiapolaau and one extinction O'u).

Table 5 Vertebrate fauna documented at HAVO

Standard Scientific Name	Standard Common Name
Canis familiaris	domestic dog
Felis silvestris	domestic cat
Herpestes auropunctatus	Indian mongoose
Lasiurus cinereus semotus	Hawaiian hoary bat
Mus musculus	house mouse
Ovis aries musimon	Mouflon sheep
Rattus exulans	Polynesian rat
Rattus norvegicus	Norway rat
Rattus rattus	black rat
Sus scrofa	pig
Acridotheres tristis	common myna
Alauda arvensis arvensis	Sky Lark

Alectoris chukar	chukar
Anous minutus melanogenys	Hawaiian noddy, black noddy
Arenaria interpres	ruddy turnstone
Asio flammeus sandwichensis	Hawaiian short-eared owl
Branta sandvicensis	Hawaiian Goose, Nene
Bubulcus ibis	Cattle egret
Buteo solitarius	hawaiian hawk, lo
Calidris alba	sanderling
Callipepla californica	California quail
Cardinalis cardinalis	northern cardinal
Carpodacus mexicanus	house finch
Chasiempis sandwichensis sandwichensis	Hawaii elepaio
Coturnix japonica	Japanese quail
Francolinus adspersus	Red-billed francolin
Francolinus erckelii	erckel's francolin
Fregata minor palmerstoni	great frigatebird
Garrulax canorus	melodious laughing thrush
Geopelia striata	zebra dove
Hemignathus virens virens	Hawaii 'amakihi
Heteroscelus incanus	wandering tattler
Himatione sanguinea sanguinea	`apapane
Leiothrix lutea	red-billed leiothrix
Lonchura punctulata	nutmeg mannikin
Lophura leucomelanos	Kalij pheasant
Meleagris gallopavo	wild turkey
Myadestes obscurus	'oma'o
Numenius tahitiensis	bristle-thighed curlew
Oceanodroma castro	band-rumped storm-petrel
Passer domesticus	house sparrow
Phaethon lepturus dorotheae	white-tailed tropicbird
Phalaropus fulicaria	red phalarope
Phasianus colchicus	ring-necked pheasant
Pluvialis fulva	Pacific Golden plover
Pterodroma sandwichensis	Hawaiian petrel
Sicalis flaveola	saffron finch
Streptopelia chinensis	spotted dove
Tyto alba	common barn-owl
Vestiaria coccinea	'i'iwi

Zosterops japonicus	Japanese white-eye
Cryptoblepharus poecilopleurus	Oceanic snake-eyed skink
Hemidactylus frenatus	bridled house gecko, common house gecko
Lampropholis delicata	garden skink, metallic skink
Trachemys scripta elegans	red-eared slider
Bufo marinus	giant toad, marine toad
Rana catesbeiana	Bullfrog

KAHO: The Park contains some of few wetlands habitats suitable for native birds on the Island of Hawaii. 'Aimakapa and Kaloko ponds are especially important areas for protecting rare and endangered bird species such as the Hawaiian coot and Hawaiian stilt. **A** wide variety of accidental or rare stragglers have been recorded at the ponds and park coastline. Several species of migratory waterfowl often winter at the ponds. Waterbirds are threatened by periodic outbreaks of avian botulism as well as by predation by feral cats, rats and mongooses. Occasional sightings of the endangered Hawaiian bat have been made in the park.

Table 6 Vertebrate fauna documented at KAHO

Standard Scientific Name	Standard Common Name
Canis familiaris	domestic dog
Felis silvestris	domestic cat
Herpestes auropunctatus	indian mongoose
Lasiurus cinereus semotus	Hawaiian hoary bat
Mus musculus	house mouse
Rattus exulans	Polynesian rat
Rattus norvegicus	Norway rat
Rattus rattus	black rat
Acridotheres tristis	common myna
Actitis macularia	spotted sandpiper
Anas acuta	northern pintail
Anas americana	american wigeon
Anas clypeata	northern shoveler
Anas crecca	green-winged teal
Anas cyanoptera	cinnamon teal
Anas discors	blue-winged teal
Anas penelope	eurasian wigeon
Anas platyrhynchos	mallard
Anas querquedula	garganey
Anas strepera	gadwall
Anous minutus melanogenys	Hawaiian noddy, black noddy
Arenaria interpres	ruddy turnstone
Asio flammeus sandwichensis	Hawaiian short-eared owl

Aythya affinis	lesser scaup
Aythya americana	redhead
Aythya collaris	ring-necked duck
Aythya marila	greater scaup
Aythya valisineria	canvasback
Branta bernicla	brant
Bubulcus ibis	cattle egret
Calidris acuminata	sharp-tailed sandpiper
Calidris alba	sanderling
Calidris alpina	dunlin
Calidris mauri	western sandpiper
Calidris melanotos	pectoral sandpiper
Calidris minutilla	least sandpiper
Calidris ruficollis	red-necked stint
Cardinalis cardinalis	northern cardinal
Carpodacus mexicanus	house finch
Ceryle alcyon	belted kingfisher
Charadrius semipalmatus	semipalmated plover
Chlidonias niger	black tern
Egretta thula	snowy egret
Estrilda caerulescens	lavender waxbill
Francolinus francolinus	black francolin
Francolinus pondicerianus	gray francolin
Fregata minor palmerstoni	great frigatebird
Fulica alai	Hawaiian Coot
Fulica americana americana	American Coot
Geopelia striata	zebra dove
Heteroscelus incanus	wandering tattler
Himantopus mexicanus knudseni	Hawaiian stilt, ae'o
Larus atricilla	laughing gull
Larus delawarensis	ring-billed gull
Larus glaucescens	glaucous-winged gull
Larus philadelphia	bonaparte's gull
Larus pipixcan	franklin's gull
Limnodromus	dowitchers
Limnodromus griseus	short-billed dowitcher
Limnodromus scolopaceus	long-billed dowitcher
Limosa lapponica	bar-tailed godwit
Lonchura malabarica	warbling silverbill

Lonchura punctulata	nutmeg mannikin
Lophodytes cucullatus	hooded merganser
Mimus polyglottos	northern mockingbird
Numenius tahitiensis	bristle-thighed curlew
Nycticorax nycticorax hoactli	Black-crowned night heron
Padda oryzivora	java sparrow
Pandion haliaetus	osprey
Paroaria capitata	yellow-billed cardinal
Passer domesticus	house sparrow
Phalaropus tricolor	wilson's phalarope
Plegadis chihi	White-faced ibis
Pluvialis fulva	Pacific Golden Plover
Pluvialis squatarola	black-bellied plover
Podilymbus podiceps	Pied-billed grebe
Puffinus pacificus chlororhynchus	Wedge-tailed shearwater
Serinus mozambicus	yellow-fronted canary
Sicalis flaveola	saffron finch
Sterna albifrons	little tern
Sterna antillarum	least tern
Streptopelia chinensis	spotted dove
Sula leucogaster plotus	'a, brown booby
Tringa flavipes	lesser yellowlegs
Tyto alba	common barn-owl
Zosterops japonicus	japanese white-eye

KALA: The Park provides habitat for the Hawaiian Petrel (`Ua`u), Newell's Shearwater (`A`o), and the endangered Hawaiian Monk seal. Introduced animals include axis deer, feral goats, feral pigs, mongoose and rats. The vegetation of KALA is threatened by feral goats, pigs, and axis deer. Ungulates are the most damaging to the Park's resources, especially in the dry forest. Pigs are a particular problem on the Pu`u `Ali`i plateau and in Waikolu valley. Detrimental effects include both direct destruction through digging and herbivory, and erosion caused by loose soil and reduced vegetation, which reduces soil quality and affects stream resources, increasing sedimentation and affecting nutrient load. Other invasive animals are also important threats: rats eat native snails, plant seeds, and bird eggs; mongooses eat bird eggs, chicks, and adults. Avian disease has probably played a large role in the loss of native Hawaiian forest birds at Kalaupapa and on Molokai in general. There have been recent sightings of I`iwi at TNCH's Kamakou preserve (Sam Aruch pers. comm.) Off-shore islets provide nesting habitat for seabirds.

Table 7 Vertebrate fauna documented at KALA

Standard Scientific Name	Standard Common Name
Axis axis	Axis deer

Canis familiaris	domestic dog
Capra hircus	goat
Equus caballus	horse
Felis silvestris	domestic cat
Herpestes auropunctatus	indian mongoose
Mus musculus	house mouse
Rattus exulans	Polynesian rat
Rattus norvegicus	Norway rat
Rattus rattus	black rat
Sus scrofa	pig
Anous minutus melanogenys	Hawaiian noddy, black noddy
Bulweria bulwerii	Bulwer's petrel
Carpodacus mexicanus	house finch
Cettia diphone	japanese bush-warbler
Francolinus francolinus	black francolin
Fregata minor palmerstoni	great frigatebird
Hemignathus virens wilsoni	Maui 'amakihi
Himatione sanguinea sanguinea	`apapane
Leiothrix lutea	red-billed leiothrix
Phaethon lepturus dorotheae	white-tailed tropicbird
Phaethon rubricauda rothschildi	red-tailed tropicbird
Puffinus auricularis	'a'o, manx, newell's townsend's shearwater
Puffinus pacificus chlororhynchus	Wedge-tailed shearwater
Streptopelia chinensis	spotted dove
Sula leucogaster plotus	'a, brown booby
Sula sula rubripes	Red-footed booby
Vestiaria coccinea	'i'iwi
Zosterops japonicus	Japanese white-eye
Cryptoblepharus poecilopleurus	Oceanic snake-eyed skink
Gehyra mutilata	stump-toed gecko
Hemidactylus frenatus	bridled house gecko, common house gecko
Hemidactylus garnotii	Indo-Pacific gecko, fox gecko
Hemiphyllodactylus typus	Indo-Pacific tree gecko, small tree gecko
Lampropholis delicata	garden skink, metallic skink
Lepidodactylus lugubris	mourning gecko
Lipinia noctua	moth skink
Bufo marinus	giant toad, marine toad

NPSA: National Park of American Samoa has three native bat species, 24 resident land and water birds, 20 resident seabirds, 7 skinks, 4 geckos, 2 sea turtles, 1 snake, and occasional other visitors. Introduced non-native vertebrates include rats (Polynesian, roof, Norway), House Mouse, dogs, feral pigs, cats, marine toads, house gecko, and birds (jungle and common myna, bulbuls).

Table 8 Vertebrate fauna documented at NPSA

Standard Scientific Name	Standard Common Name
Emballonura semicaudata	Mariana sheath-tailed bat
Pteropus samoensis	Samoa flying fox
Pteropus tonganus	insular flying fox
Sus scrofa	pig, pig (feral)
Aerodramus spodiopygius	white-rumped swiftlet
Anous minutus	black noddy
Anous stolidus	brown noddy
Aplonis atrifusca	Samoan starling
Aplonis tabuensis	Polynesian starling
Clytorhynchus vitiensis	fiji shrikebill
Ducula pacifica	Pacific pigeon
Eudynamys taitensis	Long-tailed cuckoo
Foulehaio carunculata	wattled honeyeater
Fregata ariel	lesser frigatebird
Fregata minor	great frigatebird
Gygis alba	white tern
Halcyon chloris	white-collared kingfisher
Myzomela cardinalis	cardinal honeyeater
Nesofregetta albigularis	White throated storm petrel
Phaethon lepturus	white-tailed tropicbird
Porphyrio porphyrio	purple swamphen
Procelsterna cerulea	blue-gray noddy
Pterodroma leucoptera	Collared petrel
Pterodroma rostrata	Tahiti petrel
Ptilinopus perousii	many-colored fruit-dove
Ptilinopus porphyraceus	purple-capped fruit-dove
Puffinus lherminieri	Audubon's shearwater
Puffinus nativitatis	Christmas shearwater
Puffinus pacificus	Wedge-tailed shearwater
Rallus philippensis	banded rail
Sula leucogaster	brown booby
Sula sula	red-footed booby

Vini australis	blue-crowned lory
Candoia bibroni	Bibron's keel-scaled boa, Pacific tree boa
Lipinia noctua	moth skink
Gehyra oceanica	big tree gecko
Emoia cyanura	copper-tailed copper-striped emoia
Emoia lawesii	Lawes' emoia, Lawes' skink
Emoia nigra	black emoia, black skink
Emoia samoensis	Samoan emoia, Samoan skink

PUHE: Terrestrial vertebrate fauna at PUHE consists almost entirely of introduced species such as mongooses, rats, and mice. Alien bird species include the Japanese white-eye, house sparrow, common mynah, Rock dove, and the Northern cardinal. Native bird species may include visits but no nesting of aukuu (*Nycticorax nycticorax hoactli*) and pueo (*Asio flammeus sandwichensis*).

Table 9 Vertebrate fauna documented at PUHE

Standard Scientific Name	Standard Common Name
Herpestes auropunctatus	indian mongoose
Mus musculus	house mouse
Rattus exulans	Polynesian rat
Rattus norvegicus	Norway rat
Rattus rattus	black rat
Acridotheres tristis	common myna
Alauda arvensis arvensis	Sky Lark
Arenaria interpres	ruddy turnstone
Asio flammeus sandwichensis	Hawaiian short-eared owl
Branta	brent geese
Branta bernicla	brant
Branta canadensis minima	Cackling Goose
Calidris alba	sanderling
Cardinalis cardinalis	northern cardinal
Carpodacus mexicanus	house finch
Charadrius semipalmatus	semipalmated plover
Columba livia	rock dove
Francolinus francolinus	black francolin
Francolinus pondicerianus	gray francolin
Fregata minor palmerstoni	great frigatebird
Fulica	coots
Geopelia striata	zebra dove
Heteroscelus incanus	wandering tattler

Larus delawarensis	ring-billed gull
Larus philadelphia	bonaparte's gull
Larus pipixcan	franklin's gull
Limnodromus griseus	short-billed dowitcher
Lonchura malabarica	warbling silverbill
Lonchura punctulata	nutmeg mannikin
Mimus polyglottos	northern mockingbird
Nycticorax nycticorax hoactli	Black-crowned night heron
Paroaria capitata	yellow-billed cardinal
Passer domesticus	house sparrow
Pluvialis fulva	Pacific Golden Plover
Serinus mozambicus	yellow-fronted canary
Sicalis flaveola	saffron finch
Sterna albifrons	little tern
Sterna antillarum	least tern
Sterna caspia	caspian tern
Streptopelia chinensis	spotted dove
Sula leucogaster plotus	'a, brown booby
Zenaida macroura	mourning dove
Zosterops japonicus	Japanese white-eye

PUHO: Birds are the predominant form of terrestrial vertebrate fauna found within the park. The 1996 Cooperative National Park Resource Studies Unit report on the birds of the park was based on counts made in September and October 1992 and March 1993. A total of 12 bird species were detected during these counts. During both of those periods, no indigenous birds, other than migratory shorebirds, were seen. The Japanese white-eyes (Zospterops japonica) and the Common myna (Acridotheres tristis) were the most widespread and common species seen in the park. The Hawaiian Hoary bat (Lasiurus cinereus semotus), the only mammal native to the Hawaiian Islands, commonly forages for flying insect prey over open areas such as forest clearings, lava fields and nearshore coastal waters such as those found adjacent to the park. Sightings have been limited to occasional and only at night over the waters offshore of the park. The Hawaiian bat is listed as an endangered species. No other threatened or endangered animal species are found within the national park. Introduced mammals include mongoose, cats, rats, and mice. The presence of mongooses and feral cats reduces the opportunity for native birds to become reestablished in the wetland. Reptiles commonly found in the park include three species of geckos and three species of skinks. Geckos are more active at night, usually seen in houses or on screens catching insects attracted to lights. Skinks are more active during the day, commonly seen sunning themselves or darting in search of insects in the open or from under rocks.

Table 10 Vertebrate fauna documented at PUHO

Standard Scientific Name	Standard Common Name
Canis familiaris	domestic dog

Felis silvestris	domestic cat
Herpestes auropunctatus	Indian mongoose
Lasiurus cinereus semotus	Hawaiian hoary bat
Mus musculus	house mouse
Rattus exulans	Polynesian rat
Rattus norvegicus	Norway rat
Rattus rattus	black rat
Sus scrofa	pig
Acridotheres tristis	common myna
Arenaria interpres	ruddy turnstone
Asio flammeus sandwichensis	Hawaiian short-eared owl
Buteo solitarius	hawaiian hawk, lo
Cardinalis cardinalis	northern cardinal
Carpodacus mexicanus	house finch
Estrilda caerulescens	lavender waxbill
Francolinus erckelii	erckel's francolin
Geopelia striata	zebra dove
Heteroscelus incanus	wandering tattler
Himantopus mexicanus knudseni	Hawaiian stilt, ae'o
Lonchura malabarica	warbling silverbill
Lonchura punctulata	nutmeg mannikin
Numenius tahitiensis	bristle-thighed curlew
Nycticorax nycticorax hoactli	Black-crown night heron
Paroaria capitata	yellow-billed cardinal
Passer domesticus	house sparrow
Phasianus colchicus	ring-necked pheasant
Pluvialis fulva	Pacific Golden Plover
Serinus mozambicus	yellow-fronted canary
Sicalis flaveola	saffron finch
Streptopelia chinensis	spotted dove
Sula leucogaster plotus	'a, brown booby
Tyto alba	common barn-owl
Zosterops japonicus	Japanese white-eye

USAR: No terrestrial vertebrate fauna species list was found for USAR.

WAPA: Of War in the Pacific National Historical Park's native forest birds only one species, the Swiftlet, may still remain. The rest, 12 species, are gone. Most are gone from Guam. Two are extinct. No other National Park has suffered such a massive loss of its biodiversity. The brown tree snake numbers, at the height of its invasion were immense. In prime habitats snake numbers were estimated to be 12,000 snakes per square mile, perhaps the greatest density of snakes

anywhere in the world. With a massive decline in prey, snake numbers are much less. Still, resilient populations of alien mice, rats, lizards and geckos support a sizable snake population, particularly in villages.

Table 11 Vertebrate fauna documented at WAPA

Standard Scientific Name	Standard Common Name
Canis familiaris	domestic dog
Cervus mariannus	Philippine deer
Felis silvestris	domestic cat
Rattus spp.	rat
Sus scrofa	pig
Ardea herodias	great blue heron
Anolis carolinensis	green anole
Hemidactylus frenatus	common house gecko
Varanus	monitor lizards
Gehyra mutilata	stump-toed gecko
Carlia fusca	brown four-fingered skink
Boiga irregularis	brown tree snake
Bufo marinus	marine toad
Birgus latro	Coconut crab